WHAT IS CLAIMED IS:

1. An ionization gas sensor, comprising:

a first electrode;

a second electrode comprising a carbon nanotube film; and

a voltage source electrically connected to the first and to the second electrodes, wherein the voltage source is adapted to generate an electric field near tips of carbon nanotubes in the carbon nanotube film which induces electrical breakdown of an analyte gas;

wherein the sensor is adapted to determine at least one of an analyte gas species and an analyte gas concentration for pure analyte gases and for analyte gases located in an analyte gas mixture.

2. An ionization gas sensor, comprising:

a first electrode;

a second electrode comprising a carbon nanotube film having a carbon nanotube density such that the film behaves as a conducting sheet electrode; and

a voltage source electrically connected to the first and to the second electrodes, wherein the voltage source is adapted to generate an electric field near tips of carbon nanotubes in the carbon nanotube film which induces electrical breakdown of an analyte gas.

3. An ionization gas sensor, comprising:

a first cathode electrode;

a second anode electrode comprising a carbon nanotube film; and

a voltage source electrically connected to the first and to the second electrodes, wherein the voltage source is adapted to generate an electric field near tips of carbon nanotubes in the carbon nanotube film which induces electrical breakdown of an analyte gas.

4. An ionization gas sensor, comprising:

a first electrode;

a second electrode comprising a single walled carbon nanotube film; and

a voltage source electrically connected to the first and to the second electrodes, wherein the voltage source is adapted to generate an electric field near tips of carbon nanotubes in the carbon nanotube film which induces electrical breakdown of an analyte gas.

5. An ionization gas sensor, comprising:

a first electrode;

a second electrode comprising a carbon nanotube film;

a voltage source electrically connected to the first and to the second electrodes, wherein the voltage source is adapted to generate an electric field near tips of carbon nanotubes in the carbon nanotube film which induces electrical breakdown of an analyte gas; and

a microfabricated ionization chamber containing the first and the second electrodes.

6. An ionization gas sensor, comprising:

a first electrode;

a second electrode comprising a carbon nanotube film; and

a battery powered voltage source electrically connected to the first and to the second electrodes, wherein the voltage source is adapted to generate an electric field near tips of carbon nanotubes in the carbon nanotube film which induces electrical breakdown of an analyte gas.

7. An ionization gas sensor, comprising:

a first electrode;

a second electrode comprising a carbon nanotube film;

a voltage source electrically connected to the first and to the second electrodes, wherein the voltage source is adapted to generate an electric field near tips of carbon nanotubes in the carbon nanotube film which induces electrical breakdown of an analyte gas; and

a gas chromatography device which is adapted to separate a gas mixture containing the analyte gas into constituent gases being provided into a gas detection volume between the first and the second electrodes.

8. The sensor of any claims 1 to 7, further comprising a means for determining at least one of an analyte gas species and an analyte gas concentration for pure analyte gases and for analyte gases located in an analyte gas mixture.

9. The sensor of any claims 1 to 7, further comprising a voltmeter which is adapted to detect a breakdown voltage of the analyte gas to determine the analyte gas species.

10. The sensor of any claims 1 to 7, further comprising an ammeter which is adapted to detect a self-sustaining current discharge between the first and the second electrodes to determine a concentration of the analyte gas.

11. The sensor of any claims 1 to 7, wherein the electric field near tips of carbon nanotubes in the carbon nanotube film which induces electrical breakdown of an analyte gas produces a corona or conducting filament of highly ionized gas that surrounds the nanotube tips, which promotes a formation of an electron avalanche or plasma streamer that bridges a gap between the first and the second electrodes and allows a self-sustaining inter-electrode arc discharge to be created.

12. The sensor of any claims 1 to 7, wherein:

the first electrode comprises a sheet shaped metal or metal alloy cathode;

the second electrode comprises a sheet shaped carbon nanotube film anode with the carbon nanotubes aligned and extending toward the first electrode; and

a gas detection volume is formed between one surface of the first electrode and tips of the nanotubes of the second electrode.

13. The sensor of any claims 1, 2, 4, 5, 6 or 7, wherein the carbon nanotubes comprise aligned multi-walled carbon nanotubes which extend toward the first electrode.

14. The sensor of claim 5, wherein the microfabricated ionization chamber comprises a gas impermeable chamber comprising:

an upper portion comprising:

an upper substrate containing the first electrode on an inner surface of the upper substrate;

at least one upper conductive contact pad on an outer surface of the upper substrate; and

a metal contact fill which is located in a via trench in the upper substrate, and which electrically connects the first electrode with the at least one upper contact pad;

a lower portion comprising:

a lower substrate;

a template material layer located over an inner surface of the lower substrate;

at least one conductive contact pad on an outer surface of the lower substrate; and

a metal contact fill which is located in a via trench in the lower substrate and which electrically connects the second electrode with the at least one lower contact pad; and

wherein the second electrode is located on the template material layer, such that a 10 to 50 nanoliter gas detection volume is formed between one surface of the first electrode and tips of the nanotubes of the second electrode.

15. The sensor of any claims 1 to 7, wherein an average spacing between centers of adjacent nanotubes in the nanotube film is 40 to 100 nm.

16. A method of determining at least one of an analyte gas species and concentration, comprising:

providing the analyte gas into gas a detection volume located between a first electrode and a second electrode comprising a carbon nanotube film;

generating an electric field near tips of carbon nanotubes in the carbon nanotube film to induce an electrical breakdown of the analyte gas; and

determining at least one of an analyte gas species and an analyte gas concentration of the analyte gas irrespective of whether the analyte gas comprises a pure analyte gas or if the analyte gas is located in a gas mixture.

17. The method of claim 16, wherein the carbon nanotube film has a carbon nanotube density such that the film behaves as a conducting sheet electrode.

18. The method of claims 16 or 17, wherein the first electrode comprises a cathode electrode and the second electrode comprises an anode electrode.

19. The method of any claims 16 to 18, wherein:

the first electrode comprises a sheet shaped metal or metal alloy cathode;

the second electrode comprises a sheet shaped carbon nanotube film anode with the carbon nanotubes aligned and extending toward the first electrode;

the gas detection volume is formed between one surface of the first electrode and tips of the nanotubes of the second electrode; and

the carbon nanotubes comprise single walled or multi-walled carbon nanotubes.

20. The method of any claims 16 to 19, wherein:

the step of providing an analyte gas comprising providing the analyte gas into a gas impermeable microfabricated ionization chamber through a gas inlet port; and

the gas detection volume of the chamber is 10 to 50 nanoliters.

21. The method of any claims 16 to 20, further comprising providing a voltage between the first and the second electrodes from a battery powered power source to generate the electric field near the tips of carbon nanotubes.

22. The method of claim 21, wherein the voltage is 130 V or less.

23. The method of any claims 16 to 22, further comprising separating a gas mixture containing the analyte gas into constituent gases, and sequentially providing the constituent gases into the gas detection volume.

24. The method of any claims 16 to 23, wherein the step of determining the analyte gas species comprises measuring a breakdown voltage of the analyte gas and determining the analyte gas species from the measured breakdown voltage.

25. The method of any claims 16 to 24, wherein the step of determining the analyte gas concentration comprises measuring a self-sustaining current discharge between the first and the second electrodes and determining the analyte gas concentration from the measured current.

26. The method of any claims 16 to 25, wherein the electric field near the tips of carbon nanotubes in the carbon nanotube film which induces electrical breakdown of the analyte gas produces a corona or conducting filament of highly ionized gas that surrounds the nanotube tips, which promotes a formation of an electron avalanche or plasma streamer that bridges the gas detection volume between the first and the second electrodes and allows a self-sustaining inter-electrode arc discharge to be created.

27. A method of making a microfabricated ionization chamber for an ionization gas sensor, comprising:

providing an first substrate;

forming a first electrode on an inner surface of the first substrate;

forming a first via trench exposing the first electrode and gas inlet and outlet ports through the first substrate;

filling the first via trench with a first metal contact fill;

forming at least one first conductive contact pad on an outer surface of the first substrate and in contact with the first metal contact fill;

providing a second substrate;

forming a template material layer over an inner surface of the second substrate;

forming a second via trench through the second substrate exposing the template material;

filling the second via trench with a second metal contact fill;

forming at least one second conductive contact pad on an outer surface of the second substrate and in contact with the second metal contact fill;

selectively growing a carbon nanotube film on the template material layer using selective CVD to form a second electrode; and

attaching the first substrate to the second substrate to form a gas detection volume between the first and the second electrodes.

28. The method of claim 27, further comprising:

forming an etch stop layer on an inner surface of the second substrate; and

forming a spacer between the first and second substrates.

29. The method of claim 28, wherein:

the step of forming the template material layer comprises forming the template material layer on the etch stop layer; and

the step of forming the second via trench comprises etching the second via trench through the second substrate stopping on the etch stop layer using a first etching medium, and further etching the via trench through the etch stop layer to expose the template material using a second etching medium different from the first etching medium.

30. The method of claim 30, wherein:

the first substrate comprises a photosensitive glass plate;

the step of forming the first via trench and the ports comprises selectively exposing regions in the first substrate and selectively etching the exposed regions;

the step of forming the first electrode comprises photolithgraphically patterning a first electrode layer;

the template material comprises a gold template material;

the step of selectively growing the carbon nanotube film comprises selectively growing a multi-walled carbon nanotube film which behaves as a conducting sheet electrode from a vapor mixture comprising xylenes and ferrocene; and

the gas detection volume is 10 to 50 nanoliters.